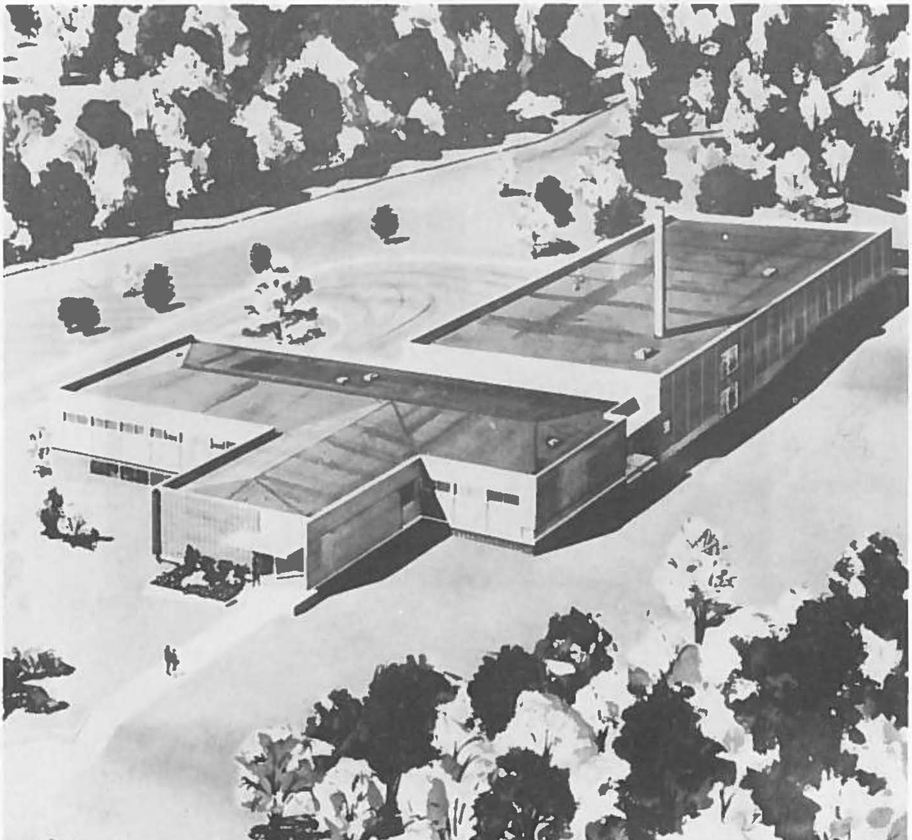
Historical file

ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE



NATIONAL NAVAL MEDICAL CENTER
BETHESDA, MARYLAND

RADM. Robert B. BROWN, MC, USN
Commanding Officer, National Naval Medical Center

CAPT. Robert O. CANADA, MC, USN
Deputy Commanding Officer, National Naval Medical Center

ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE

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Even prior to the establishment of voluntary moratorium on nuclear testing in 1958, many scientists recognized that a laboratory radiation source capable of simulating the radiation spectrum from a nuclear detonation would be desirable. Such a source would be desirable as a means of corroborating and extending results obtained from biomedical field tests as well as furnishing an opportunity to "proofcheck" proposed field tests.

The 1958 executive directive ordering the unilateral cessation of nuclear tests made the need for such a source more urgent. This need was recognized by the Bureau of Medicine and Surgery of the U. S. Navy who proposed to the Armed Forces Special Weapons Project (now the Defense Atomic Support Agency) in August 1958 that a biomedical nuclear reactor facility be established at the National Naval Medical Center.

In the original proposal it was pointed out that "further action on the implementation of the proposal cannot be taken until assurance of support is provided by other interested government agencies." The Offices of the Surgeons General of the Army and Air Force signified their interest in the development of such a facility. In addition, the Public Health Service, Division of Biology and Medicine of the Atomic Energy Commission, and the Office of Civil and Defense Mobilization concurred in this need as did Dr. Frank Berry, then Assistant Secretary of Defense (Health & Medical).

In October 1959 the Deputy Assistant Secretary of Defense stated that, "The Director of Defense Research and Engineering has also recommended support of a Defense Atomic Support Agency proposal for a biomedical research reactor to be located at the National Naval Medical Center, Bethesda, Maryland."

The official interest of DASA lies in the effects of nuclear weapons, in their research and development, testing and evaluation, storage, movement, and eventual utilization if indicated. This interest also extends to the vehicular reliability of their conveying medium and its hazard and safety because, in the end, people are always involved in a man-machine-weapons system concept. If the man fails the system may fail; therefore, DASA has an interest in the effects of radiation upon man, regardless of its source. It is for this reason that DASA became concerned in sponsoring the construction of this facility. DASA recognized the urgent necessity for the conduct of research in the biologic effects of radiation, whether basic or applied, and whether directly or indirectly related to nuclear weapons effects.

Accordingly DASA proceeded with the design and justification of the Institute. During this period it was felt that the TRIGA nuclear reactor, developed by the General Atomics Division, fulfilled most of the criteria to serve as the primary radiation source. The TRIGA is inherently safe due to the physical properties of its uranium-zirconium hydride fuel elements. These give the reactor core a prompt negative temperature coefficient. Any insertion of excess reactivity causes an

automatic immediate return to normal power levels. As a result modifications of the TRIGA core have been shown capable of safe repetitive flashing, making pulsed radiation a practical reality. This characteristic along with others, will be discussed in greater detail shortly. A thorough analysis of the TRIGA radiation spectrum revealed a need to provide fast neutrons as well as high energy, pure x-radiation. Accordingly a 30 Mev accelerator was added to the original plans as a second major radiation source.

Once Congressional approval was secured, plans went forward at a rapid pace. Construction began in

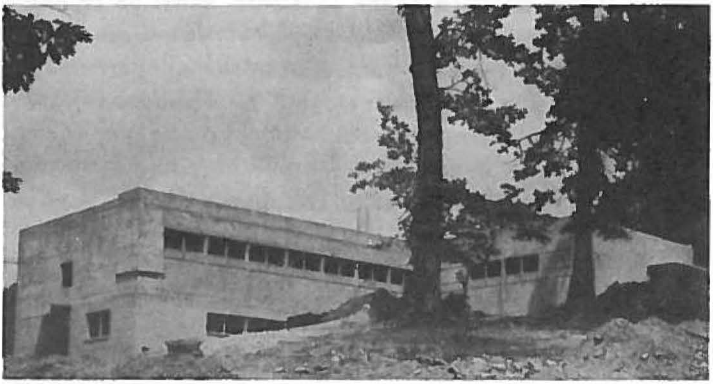


Figure 1. - Status of the Building in July 1961

late fall 1960 at the National Naval Medical Center, Bethesda, Maryland -- with completion scheduled for December 1961.

On May 12 1961 the Department of Defense issued a directive formally establishing the Institute. The following three paragraphs of the directive are quoted in their entirety:

a. "The Institute shall serve primarily as radiobiology research laboratories for the Department of Defense. The National Institutes of Health, Atomic Energy Commission, and other federal and civilian institutions may utilize the laboratories as agreed upon by the Secretary of Defense or his designee."

b. "The mission of the Institute shall be to conduct scientific research in the field of radiobiology and related matters that are essential to the support of the United States military services, to national welfare, and to the well-being of mankind."

c. "Under Department of Defense policies, the Institute shall:

(1) Provide facilities for research on the biological effects of ionizing radiation.

(2) Conduct advanced training and educational programs.

(3) Provide facilities for radioisotope production.

(4) Perform such other functions as may be assigned."

The Board of Governors of the AFRRI is comprised of the Chief, DASA and the Surgeons General of the three Military Services. They met recently and nominated the following officers to serve as Directorate of the Institute: Colonel James T. Brennan, MC, USA was nominated as Director, with Captain Francis W. Chambers, Jr., MSC, USN, and Lieutenant Colonel Carl L. Hansen, Jr., USAF, MC, nominated as Deputy Directors, representing the other two Armed Services. During July 1961 the Secretary of the Navy confirmed these nominations and formally approved the Directorate.

Thus, the Armed Forces Radiobiology Research Institute has become a reality. Scientific personnel, both civilian and military are being sought and research programs formulated. A total of 67 civilian spaces is contemplated. Additional information regarding the Institute may be obtained by contacting the Director by mail or telephone. The mailing address is:

Director
Armed Forces Radiobiology Research Institute
National Naval Medical Center
Bethesda 14, Maryland

The telephone number is OLiver 4-2500, extensions 571 or 688.

The remainder of the brochure will be devoted to a more complete description of the radiation sources. It may be of interest to note that the exposure facilities have been designed to permit the addition of a positive ion accelerator at a later date.

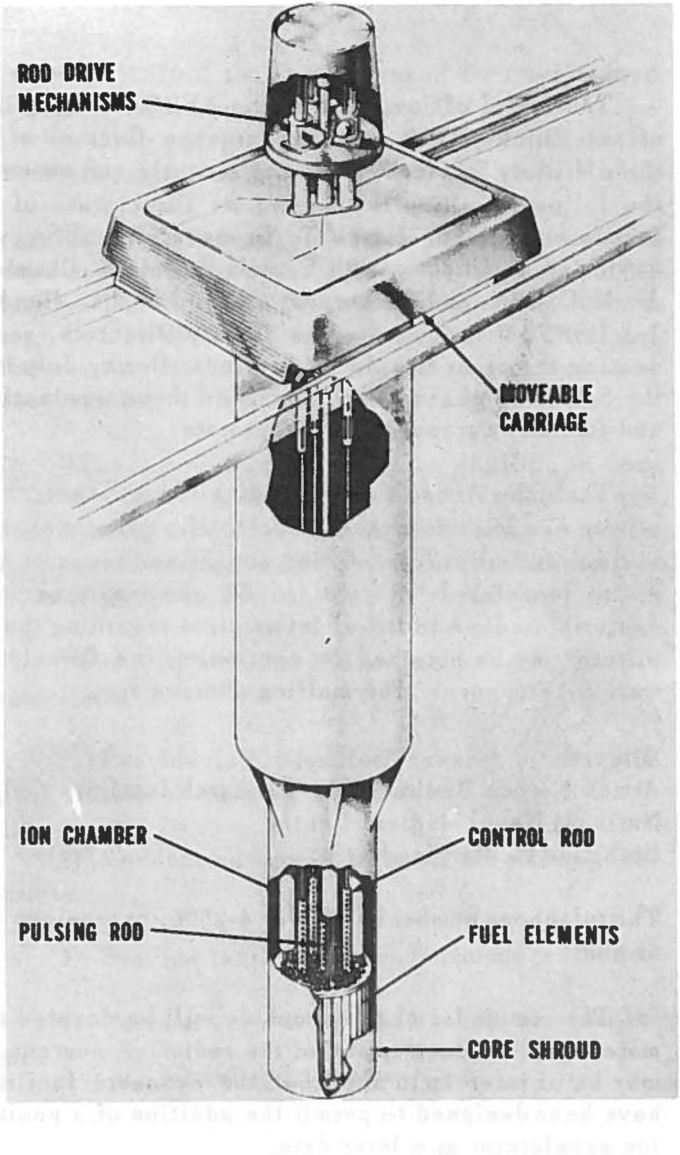

ROD DRIVE
MECHANISMS
MOVEABLE
CARRIAGE
ION CHAMBER
CONTROL ROD
PULSING ROD
FUEL ELEMENTS
CORE SHROUD

Figure 2

DASA - TRIGA MARK F REACTOR

This reactor is the primary radiation source of AFRRI. The name of the reactor arises from the fact that DASA sponsored the program and requested the funds for the construction of the entire facility at the National Naval Medical Center. TRIGA is a name coined by the General Atomic Division, General Dynamics Corporation to represent a family of inherently safe reactors. TRIGA is derived from the triple capability of the reactor to provide "Training, Research and Isotopes."

The DASA-TRIGA nuclear reactor has both steady state and pulsing characteristics. It can be operated at 100 kw steady state, with intermittent operation at 1000 kw as well as furnishing 13 millisecond pulses to 1,200,000 kw peak power.

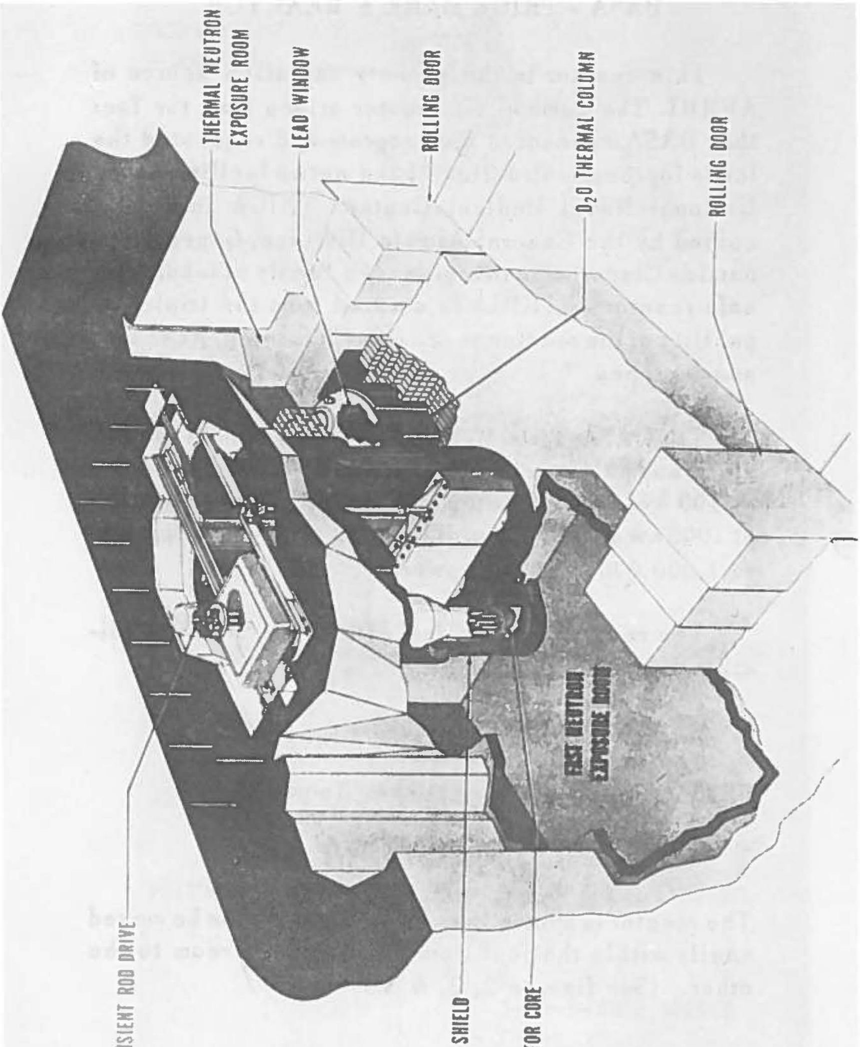
The reactor is provided with three major irradiation facilities:

a. Pool Irradiation Facility

b. Fast Neutron Exposure Room

c. Thermal Neutron Exposure Room

The reactor is mounted on a carriage and can be moved easily within the pool from one exposure room to the other. (See figures 2, 3, & 4.)



THERMAL NEUTRON EXPOSURE ROOM
LEAD WINDOW
ROLLING DOOR
D_2O THERMAL COLUMN
ROLLING DOOR
FAST NEUTRON EXPOSURE ROOM
TRANSIENT ROD DRIVE
LEAD SHIELD
REACTOR CORE

Figure 3

The Pool Irradiation Facility is approximately 13 feet in diameter and 20 feet in depth. It is equipped with eight pneumatic tubes for isotope production and activation analysis, dosimetry and microchemistry. An associated hot cell and laboratory are provided for the handling of radioactive samples. Movable lead swinging doors within the pool permit operation of the reactor in one exposure room, or in the pool while additional experiments are being set up in the other exposure room.

The Fast Neutron Exposure Room with shielding is 20 feet by 20 feet by 9 feet thus permitting the simultaneous exposure of several test objects. A unique feature of this exposure facility lies in the fact that the beam from the 30 Mev electron accelerator may also be directed into the room for simultaneous or alternate reactor and accelerator pulsed exposures.

The Thermal Neutron Exposure Room is 14 feet by 15 feet by 10 feet, and is provided with a high performance heavy water and lead thermal column. This column may easily be removed allowing the area to be used as a multipurpose or fast-neutron exposure room.

As mentioned the reactor provides remarkable flexibility. It can be routinely pulsed to a peak power level of 1,200,000 kw with a pulse of 13 milliseconds and a prompt energy release of 18 MW-sec with a 2 inch water reactor reflector and a 1.5 inch lead shield. The fast neutron dose ($>$ 10 kev) per pulse at the surface of the lead shield is 1.5×10^{13} n/cm^2/sec together with 1.5×10^4 rad/sec of

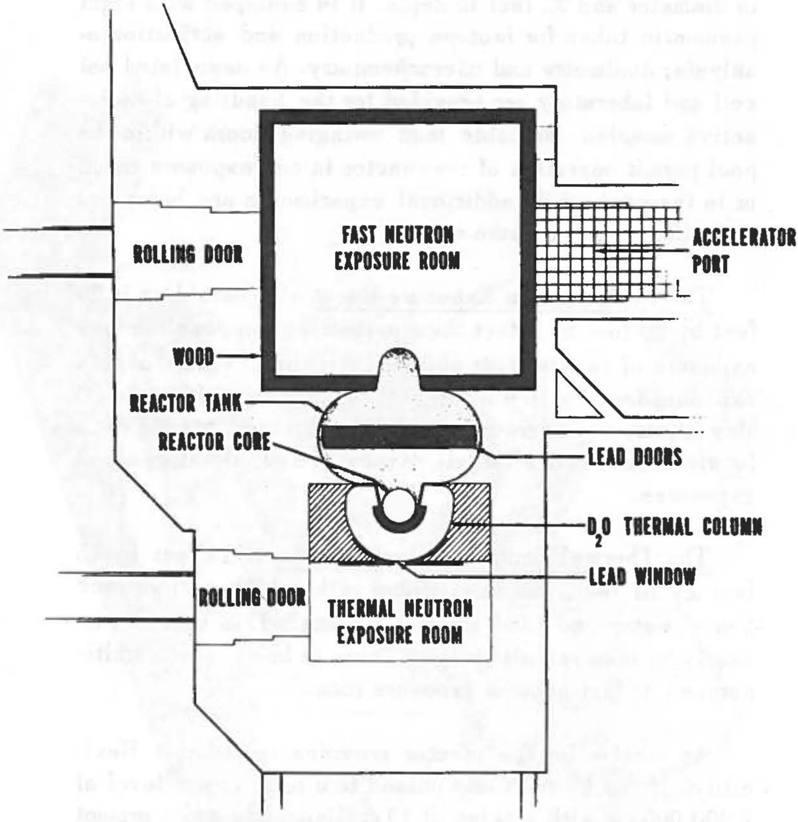

FAST NEUTRON
EXPOSURE ROOM
ROLLING DOOR
ACCELERATOR
PORT
WOOD
REACTOR TANK
REACTOR CORE
LEAD DOORS
D2O THERMAL COLUMN
LEAD WINDOW
ROLLING DOOR
THERMAL NEUTRON
EXPOSURE ROOM

Figure 4

gamma radiation. The total dose 3 feet from the center of the reactor is on the order of 8,000 rad/pulse. At 100 kw steady state the fast neutron leakage dose rates are 8×10^{10} n/cm^2/sec with 80 rad/sec of gamma radiation. In the pool at the reactor midplane on the surface of the core support, the dose rates at 100 kw are 1.5×10^{11} n/cm^2/sec of fast neutrons and 9×10^{11} n/cm^2/sec of thermal neutrons, with 600 rad/sec of gamma radiation. By means of a pneumatically actuated control rod and an electro-mechanical servo-mechanism, the reactor can be brought rapidly to 1 MW power level within a few seconds and stabilized at 1 MW until scrammed manually or at a predetermined time level. The reactor can supply an energy release of 300 MW-seconds within five-minute time intervals for a total time of one hour per day. Table 1 summarizes the pulsing characteristics of the DASA-TRIGA nuclear reactor.

30 Mev Linear Accelerator--The specifications for this radiation source are currently being written and thus are not completely available at this time. The accelerator will be rated at 30 Mev. The exposure facilities are so designed, as was mentioned earlier, to provide the opportunity for directing the accelerator beam into the fast neutron exposure room. There is also an exposure room for the accelerator itself.

AFRRI, then, offers an unparalleled opportunity to take advantage of a unique set of radiation sources. By suitable use of these capabilities it is intended that AFRRI will provide an environment conducive to the proper conduct of research into the biologic effects of radiation.

TYPICAL PULSING PERFORMANCE OF TRIGA MARK F

STEP REACTIVITY INSERTION	1.9% $\Delta k/k$
MAXIMUM POWER LEVEL	1,200 Mw
PROMPT ENERGY RELEASE	18 Mw-sec
PULSE WIDTH AT HALF MAXIMUM	13 m sec
ASYMPTOTIC REACTOR PERIOD	4 m sec
REPETITION RATE	8 PULSES PER HOUR
FAST NEUTRON FLUX (>10 k ev) (MAXIMUM AVAILABLE)	
PEAK	4.0×10^{16} NEUTRONS/CM^2-sec
INTEGRATED	6.2×10^{14} NEUTRONS/CM^2
GAMMA RADIATION (MAXIMUM AVAILABLE)	
PEAK DOSE RATE	4.0×10^{7} RADS/sec
INTEGRATED DOSE	6.0×10^{5} RADS

Table 1